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(54) **Fluid mixing or homogenization.**

(57) A non-homogenous mixture of liquid and gas is fed into a vessel (10) to form a body (30) of gas above a pool (29) of liquid. Liquid is fed from the pool through a discharge pipe (17) containing a constriction (19) forming a venturi and gas is drawn from the gas body through a pipe (24) extending through the liquid pool into the discharge pipe to effect mixing of the liquid and the gas in the venturi. Perforations (27) in the discharge pipe adjust the amounts of gas and liquid leaving the vessel to maintain both liquid and gas within the vessel.

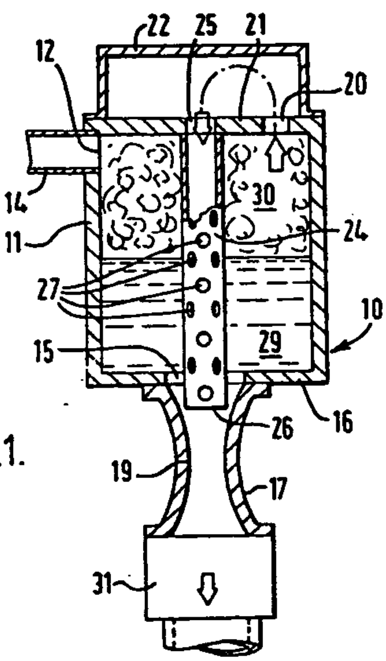

FIG.1.

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FLUID MIXING OR HOMOGENIZATION

The invention relates to the homogenization or mixing of fluids.

The invention has particular application to the treatment of fluid flows which are multi-phase, in that they comprise both gas and liquid components, but which are by no means uniformly better mixed or homogenized. A mixture of gas and oil extracted from an onshore or a subsea well, for example, can vary substantially as regards its gas and liquid components. It may comprise slugs of substantially unmixed liquid separated by primarily gaseous portions, as well as portions that are more or less homogeneous. This inconsistency of the nature of the extracted material makes it difficult to handle, in particular by pumping equipment, which could more readily deal with a more homogeneous mixture.

The invention is consequently concerned with conveniently achieving multi-phase fluid flows which are effectively mixed or homogenized and accordingly provides a method of and an apparatus for obtaining a mixed or homogenized multi-phase fluid flow in a simple and convenient way.

The invention thus provides for the formation of a liquid pool and a body of gas, as by feeding a multi-phase fluid into a tank or container, and for the withdrawal of the liquid from the pool and of the gas from the body for admixture in a venturi. The liquid flow in a discharge duct or outlet pipe containing the venturi creates suction by which the gas isdrawn into the liquid flow, as thorugh a pipe having an inlet end communicating with the upper region of the tank and an outlet end within the discharge duct at or just upstream of the venturi. The liquid flow in the discharge pipe can be induced by gravity, the tank outlet to the discharge pipe being then conveniently located in the floor of the tank. The liquid flow can instead be pump-induced or aided and the venturi can then be located directly upstream of a pump unit.

The gas component can be drawn from the gas body through an aperture in the roof of the tank which communicates with the gas supply pipe by a transverse extension thereof outside the tank or by way of a chamber mounted on the tank roof. Alternatively such a supply chamber can be separated from the main volume of the tank by a suitably apertured internal partition.

Preferably, the apparatus incorporates means tending to ensure that the tank or container always contains some of both the liquid and the gas components. The invention can accordingly provide that the supply pipe conveying the gas to the venturi extends through the pool of liquid in the tank and is provided with apertures or perforations spaced apart along it. Some of the liquid thus flows together with the gas in the supply pipe to the venturi. The amount or proportion of the gas component which is drawn off from above the liquid thus decreases as a function of an increase of the liquid level, as more of the perforations are submerged. Integral regulation is thus conveniently obtained.

The invention will thus be understood to provide a simple and effective mixing or homogenizing method and apparatus, which can operate under gravity in appropriate conditions, without the need for a power input, and which can incorporate automatically operating regulator means.

The invention is further described below, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic sectional view of a mixing or homogenising unit or apparatus embodying the invention; and

Figure 2 graphically illustrates the relationship between the liquid level in the apparatus of Figure 1 and the void fraction drawn off.

The mixing unit or apparatus of Figure 1 comprises a vessel or container 10 of generally upright cylindrical form of which the interior is closed, except for the fluid inlets and the outlets to be described. At the upper region of the cylindrical side wall 11 of the container, there is provided an inlet port 12 communicating by a pipe 14 with a source (not shown) of a multiphase fluid. A liquid outlet port 15 is provided centrally .in the floor 16 of the container 10 and communicates with an outlet or discharge pipe or fitting 17 having an internal constriction 19 which forms a venturi. A gas outlet port 20 in the roof 21 of the container communicates with an upper chamber 22 mounted on the roof. Also communicating with the chamber 22 is a generally vertical pipe 24 extending downwardly from a central aperture 25 in the roof. The pipe 24 extends downwardly through the container interior into the discharge fitting 17, the lower open end 26 of the pipe being located concentrically within the fitting just above the constriction 19 forming the venturi.

The upper portion of the container 10 thus communicates with the pipe 24 by way of the chamber 22 and for a reason explained below, this upper container portion also communicates with the pipe 24 through a series of perforations 27 through the pipe wall. The perforations 27 extend along substantially the entire length of the pipe 24 within the container.

The liquid component of a multi-phase fluid flow entering the container by way of the inlet port 12 tends

to separate under gravity from the gaseous component and forms a pool 29 in the lower part of the container. A body of the gaseous component occupies the upper part of the container, above the free surface of the liquid pool.

The liquid component is withdrawn from the pool 29 in the container through the discharge port 15 under gravity, with or without the assistance of a downstream pump 31 connected for example at the lower end of the discharge pipe 27, as schematically shown, and the effect of the venturi is to draw the gas from the upper part of the tank interior through the pipe 24 in admixture with the liquid phase, so that a homogenized or substantially homogenized fluid is obtained in the discharge pipe 17. If the multi-phase fluid flow entering the container interior is already homogenous or approximately so, then the mixture will be discharge through the pipe 27 by way of both the outlet port 15 and the open end 26.

The void fraction α of the fluid discharged from the container 10 depends on the dimensions of the venturi, and can be made independent of the total flow rate Q^T, the liquid level h in the container, and the absolute pressure ρ.

Assuming that both some liquid and some gas are present in the container, the total pressure drop for the gas and for the liquid phases flowing through it will be equal, and the void fraction from the container can be obtained from the resulting equation as follows:

$$\frac{\rho_L}{2}(1-\alpha)^2 \cdot Q_T^2 \left[\frac{(1+\xi_L)}{A_L^2} - \frac{1}{A_T^2} - \frac{2\cdot g\cdot h}{(1-\alpha)^2 \cdot Q_T^2}\right] = \frac{\rho_G}{2}\alpha^2 \cdot Q_T^2 \left[\frac{(1+\xi_G)}{A_G^2} - \frac{1}{A_T^2}\right]$$

where:
A_T - the cross-sectional area of the container,
A_L - the cross-sectional area of the liquid in the venturi,
A_G - the cross-sectional area of the gas in the venturi,
ξ_L - the total liquid loss coefficient,
ξ_G - the total gas loss coefficient,
ρ_L - the liquid density, ρ_G - the gas density, and
g - gravity.

During steady flow conditions, the average void fraction drawn from the container will equal the average void fraction entering it. To ensure that both liquid and gas are always present in the container, it is convenient to decrease the gas fraction drawn off as the liquid level increases, and vice versa, and this is achieved by the perforations 27 in the pipe 24. The perforated pipe 24 thus acts as an integral regulator allowing a variation in the void fraction.

The relation between the liquid level in the container and the void fraction drawn from it (the mixing unit characteristic) is illustrated in Figure 2. Any desired mixing unit characteristic can be obtained by appropriate choice of dimensions of the venturi and the perforations 27 in the pipe portion 24.

It will be readily appreciated that the invention can be embodied in a variety of ways other than as specifically described and illustrated.

Claims

1. An apparatus for mixing together or homogenizing a liquid and a gaseous fluid, the apparatus comprising a vessel (10) for receiving therein a pool (29) of the liquid with a body (30) of the fluid thereabove, a duct (17) for receiving a flow of liquid from the pool, the duct including a constriction (19) so as to function as a venturi, and passage means (20,22,24) supplying the fluid from the body into the discharge duct for mixing in the venturi.

2. An apparatus as claimed in claim 1 wherein the passage means (20,22,24) has means (27) for supplying also liquid from the pool (29) into the duct.

3. An apparatus as claimed in claim 2 wherein liquid supply means (24,27) is arranged so that the relative amounts of liquid and gas supplied to the duct vary so as to tend to retain both liquid and gas within the vessel (10).

4. An apparatus as claimed in claim 1 wherein the passage means comprises a supply pipe (24) extending through the liquid pool (29) and having perforations or apertures (27) at positions corresponding to different depths within the pool for entry into the supply pipe of quantities of the gas and the liquid dependent on the level of the pool.

5. An apparatus as claimed in claim 4 wherein the supply pipe (24) extends through an aperture (25) in the vessel wall of the upper end thereof and communicates with the vessel interior through a second aperture (20).

6. An apparatus as claimed in any preceding claim wherein the vessel (10) has a roof (21), a side wall (11), a floor (16), a common inlet (12) for the liquid and the fluid at the upper end of the side wall, and a discharge port (15) for the duct (17) in the floor.

7. An apparatus as claimed in any preceding claim wherein the duct (17) communicates with the inlet of a suction pump (31).

8. A method of mixing a liquid and a gaseous fluid wherein a pool is formed of the liquid with a body of the fluid above it, wherein a flow of liquid is established from the pool and through a venturi, and wherein fluid is drawn from the fluid body into the liquid flow to be mixed with it at the venturi.

9. A method as claimed in claim 8 wherein the liquid flow and the withdrawal of the fluid are such as to tend to maintain the liquid pool and the fluid body.

10. A method as claimed in claim 9 wherein the fluid is drawn from the fluid body together with liquid from the liquid pool in relative amounts dependent on the depth of the liquid pool.

11. A method as claimed in claim 8 wherein fluid is drawn from the fluid body through a pipe extending through the liquid pool, the pipe being apertured so as to receive therein a quantity of the liquid dependent on the depth of the pool.

12. A method as claimed in claim 8, 9, 10 or 11 wherein the liquid pool and the fluid body are formed by feeding into a vessel a non-homogenous mixture of the liquid and the fluid.

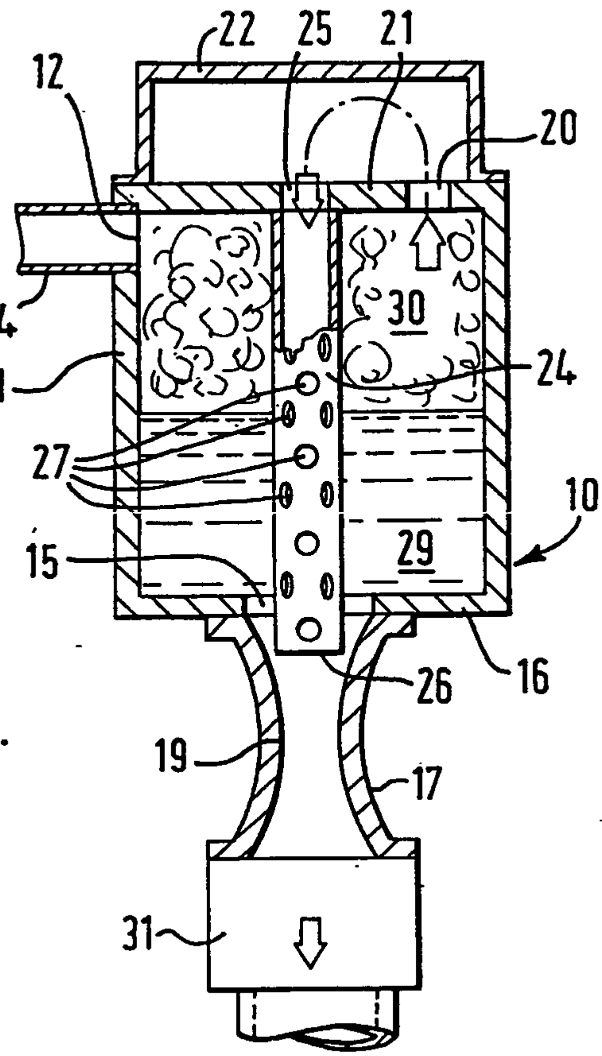
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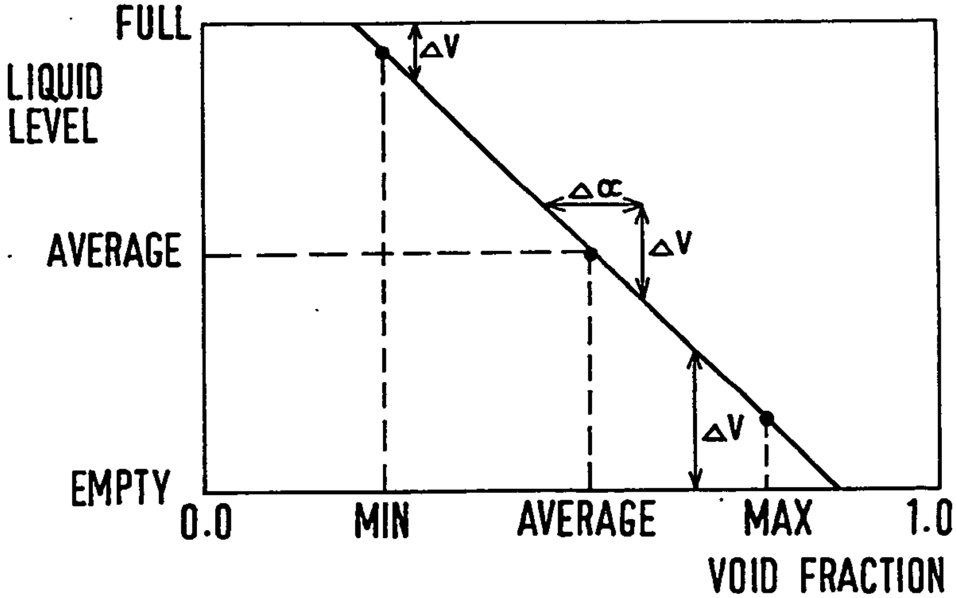
FIG.1.

FIG.2.


FULL
LIQUID LEVEL
AVERAGE
EMPTY
ΔV
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ΔV
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MIN
AVERAGE
MAX
1.0
VOID FRACTION